CSE 484 / CSE M 584 (Autumn 2011)

Introduction to Cryptography

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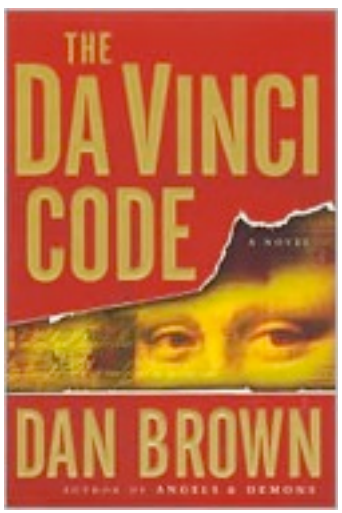
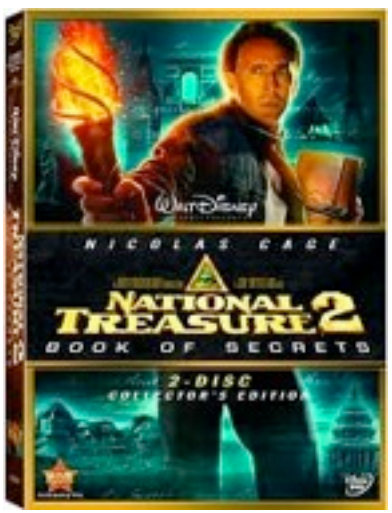
Thanks to Dan Boneh, Dieter Gollmann, John Manferdelli, John Mitchell, Vitaly Shmatikov, Bennet Yee, and many others for sample slides and materials ...

Cryptography and Security

- Art and science of *protecting* our *information*.
  - Keeping it private, if we want privacy
  - Protecting its integrity, if we want to avoid forgeries.





Images from Wikipedia and Barnes and Noble

Some thoughts about cryptography

- Cryptography only one small piece of a larger system
- Must protect entire system
  - Physical security
  - Operating system security
  - Network security
  - Users
  - **Cryptography** (following slides)
- "Security only as strong as the weakest link"
  - Need to secure weak links
  - But not always clear what the weakest link is (different adversaries and resources, different adversarial goals)
  - Crypto failures may not be (immediately) detected
- Cryptography helps after you've identified your threat model and goals

Improved security, increased risk

- RFIDs in car keys:
  - RFIDs in car keys make it harder to hotwire a car
  - Result: Car jackings increased

Improved se

- RFIDs in car ke
  - RFIDs in car k
  - Result: Car ja

boingboing
A Directory Of Wonderful Things

Biometric car lock defeated by cutting off owner's finger

POSTED BY CORY DOCTOROW, MARCH 31, 2005 7:53 AM | PERMALINK

Andrei sez, "'Malaysia car thieves steal finger.' This is what security visionaries Bruce Schneier and Ross Anderson have been warning about for a long time. Protect your $75,000 Mercedes with biometrics and you risk losing whatever body part is required by the biometric mechanism."

> ...[H]aving stripped the car, the thieves became frustrated when they wanted to restart it. They found they again could not bypass the immobiliser, which needs the owner's fingerprint to disarm it.
>
> They stripped Mr Kumaran naked and left him by the side of the road - but not before cutting off the end of his index finger with a machete.

Key Entry Pad (4-digit PIN)

- This is the key pad on my office safe.
- Inside my safe is a copy of final exam.
- How long would it take a you to break in?

Image from profmason.com

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- How long would it take a you to break in?

- Answer (combinatorics):
  - 10^4 tries *maximum*.
  - 10^4 / 2 tries on *average*.
- Answer (unit conversion):
  - 3 seconds per try --> 4 hours and 10 minutes on average

Key Entry Pad (4-digit PIN)

Image from profmason.com

- Now assume the safe automatically calls police after 3 failed attempts.
- What is the probability that you will guess the PIN within 3 tries?
- (Assume no repeat tries.)

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- Answer (combinatorics):
  - 10000 choose 3 possible choices for the 3 guesses
  - $1 \times (9999 \text{ choose } 2)$ possible choices contain the correct PIN
  - So success probability is 3 / 10000

Key Entry Pad (4-digit PIN)

- Could you do better at guessing the PIN?

Image from profmason.com

Idea from http://eprint.iacr.org/2003/217.ps

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Lesson: Consider the complete system, physical security, etc

Lesson: Think outside the box

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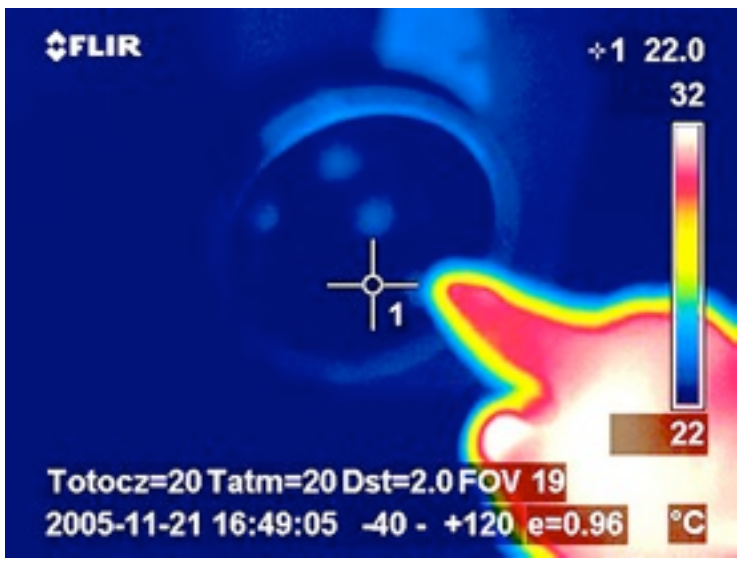
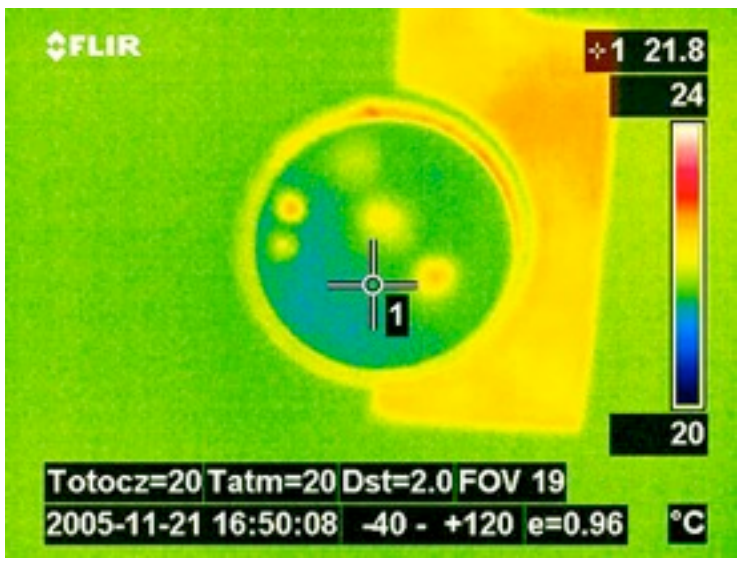
Thermal Patterns



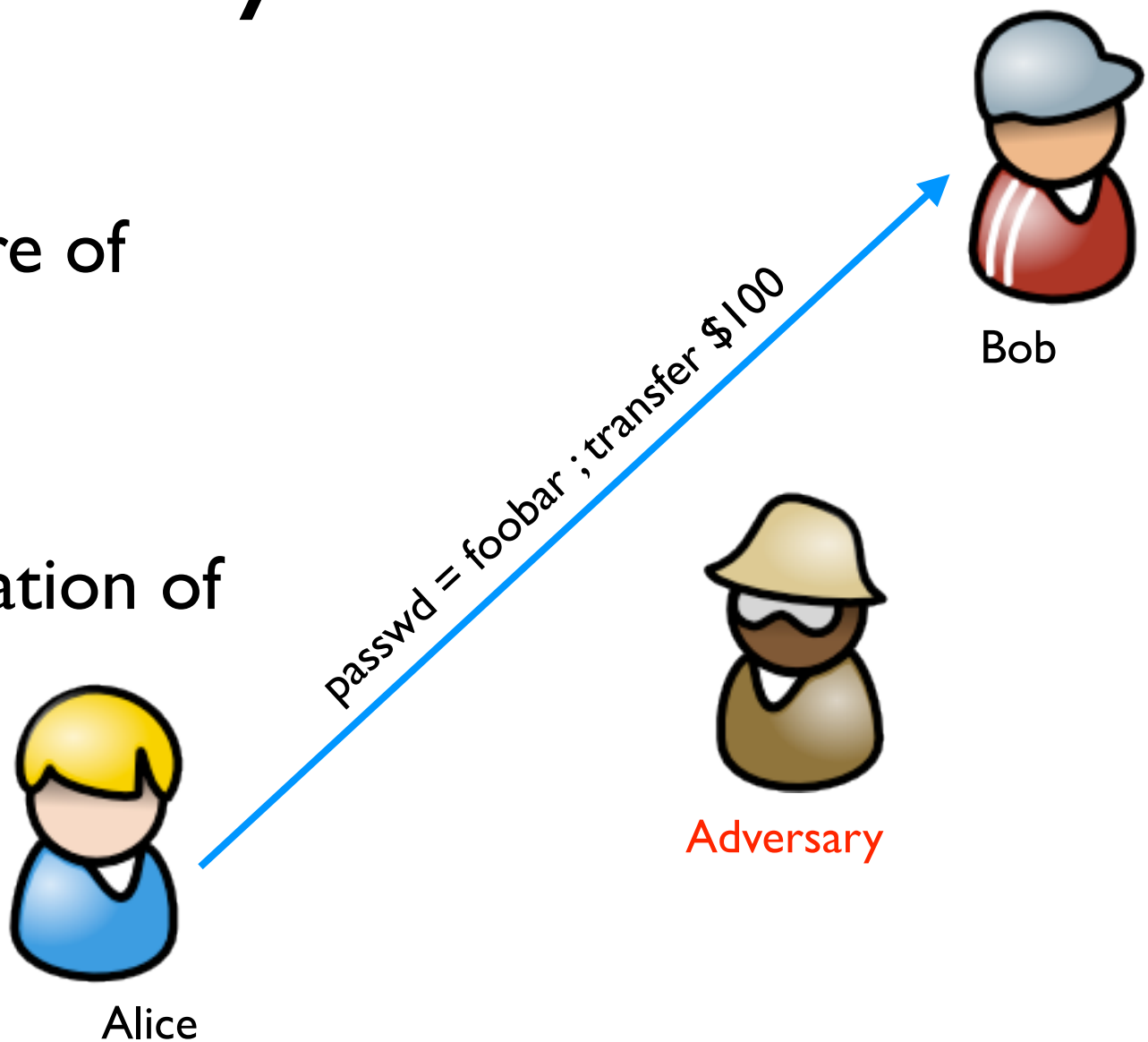


Images from http://lcamtuf.coredump.cx/tsafe/

Common Communication Security Goals

Privacy of data
Prevent exposure of information

Integrity of data
Prevent modification of information



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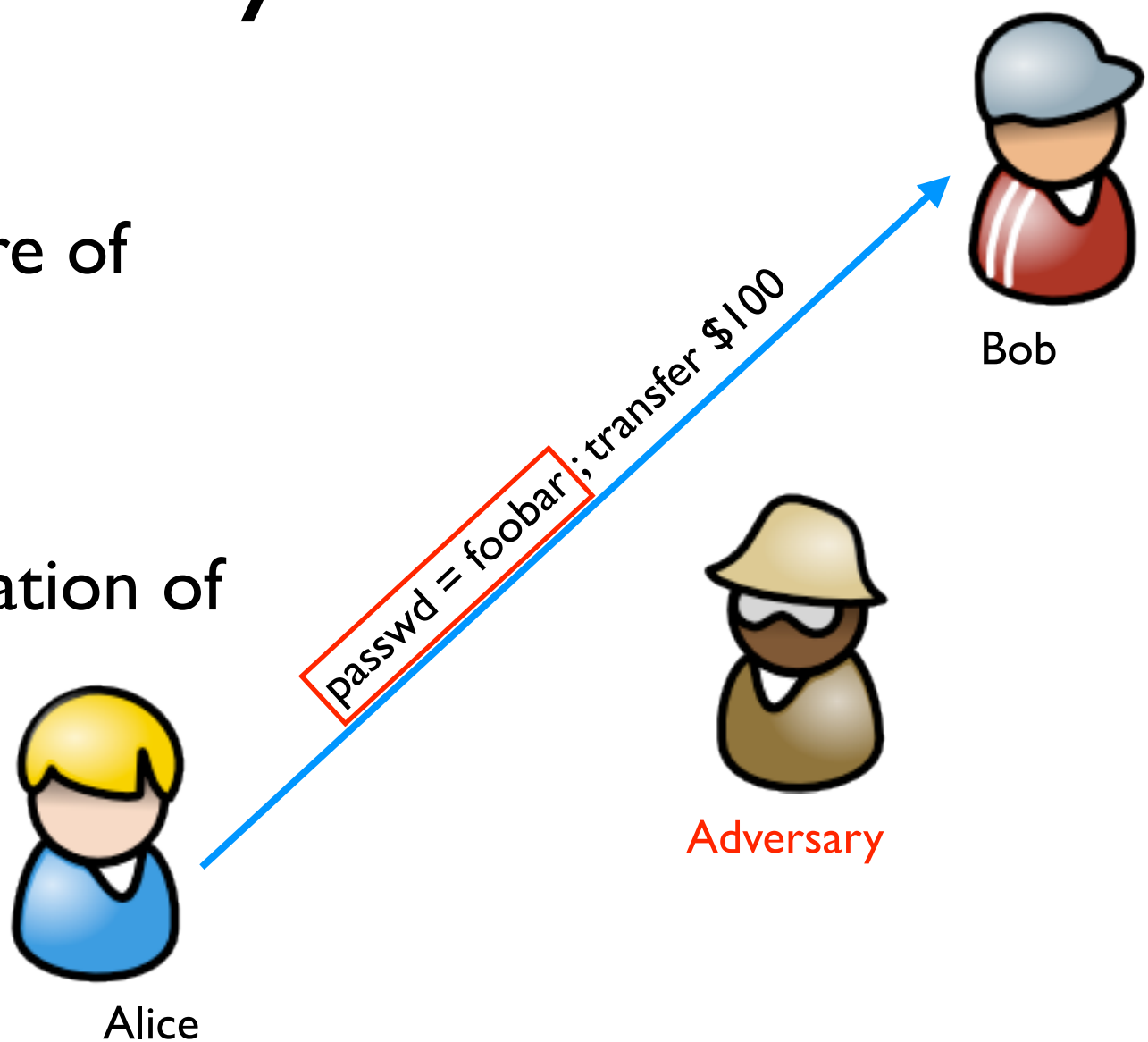

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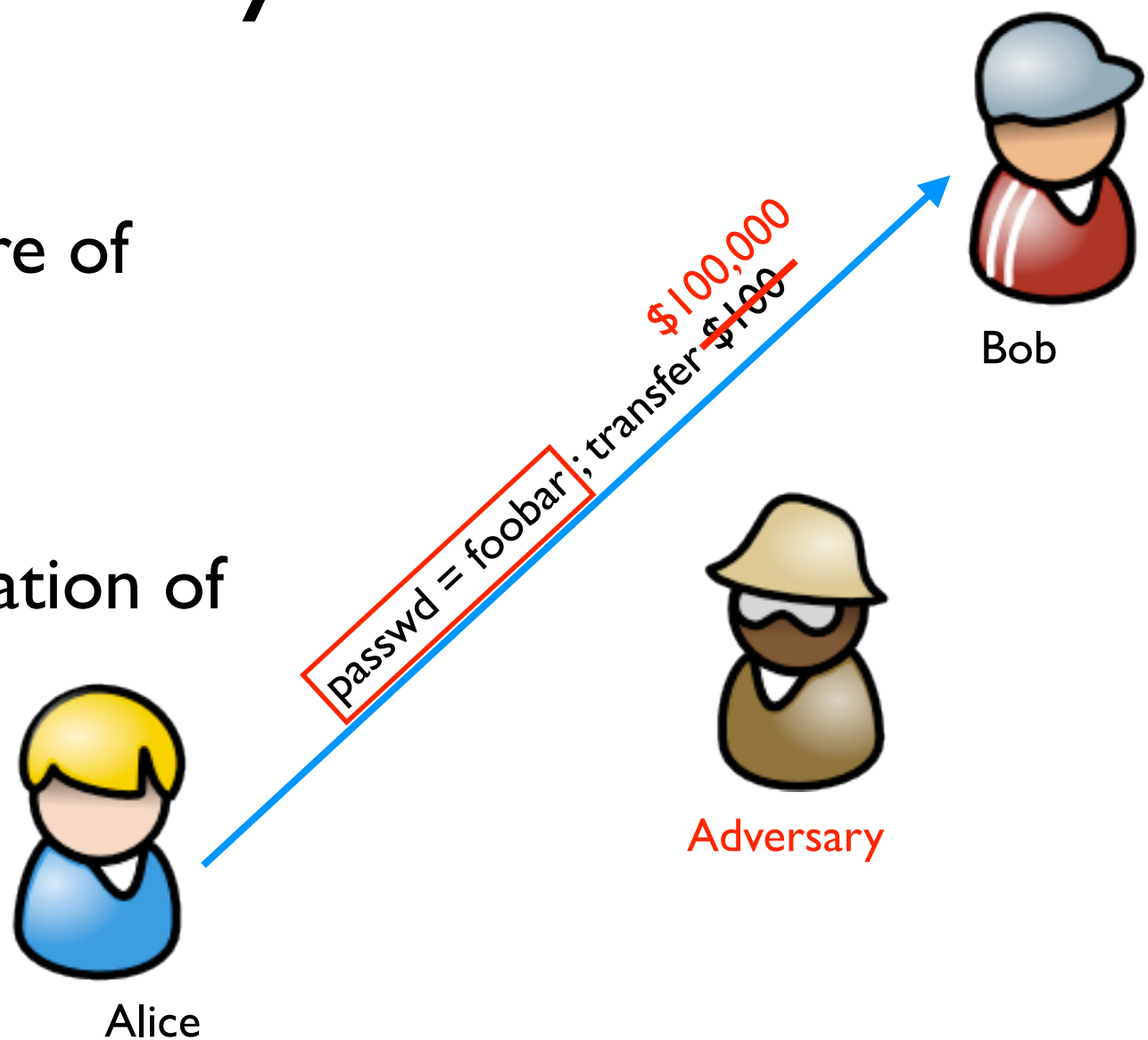
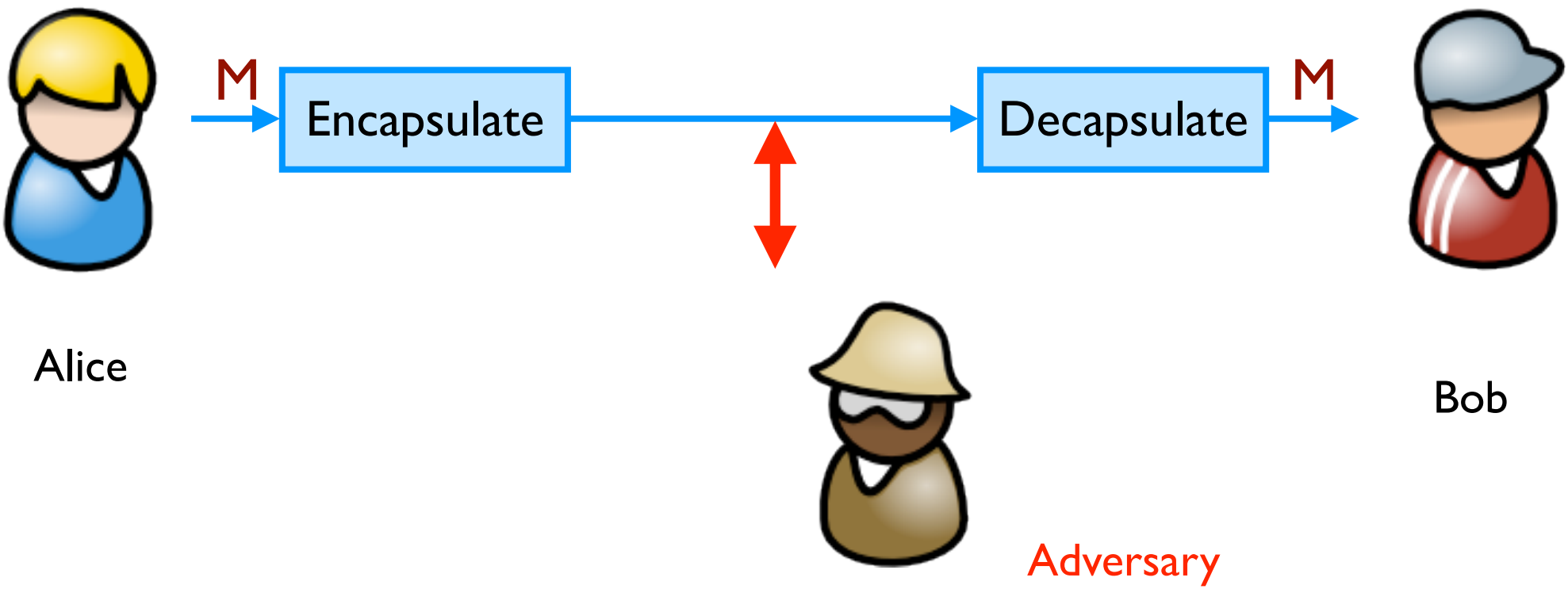


Symmetric Setting

Both communicating parties have access to a shared random string K, called the key.



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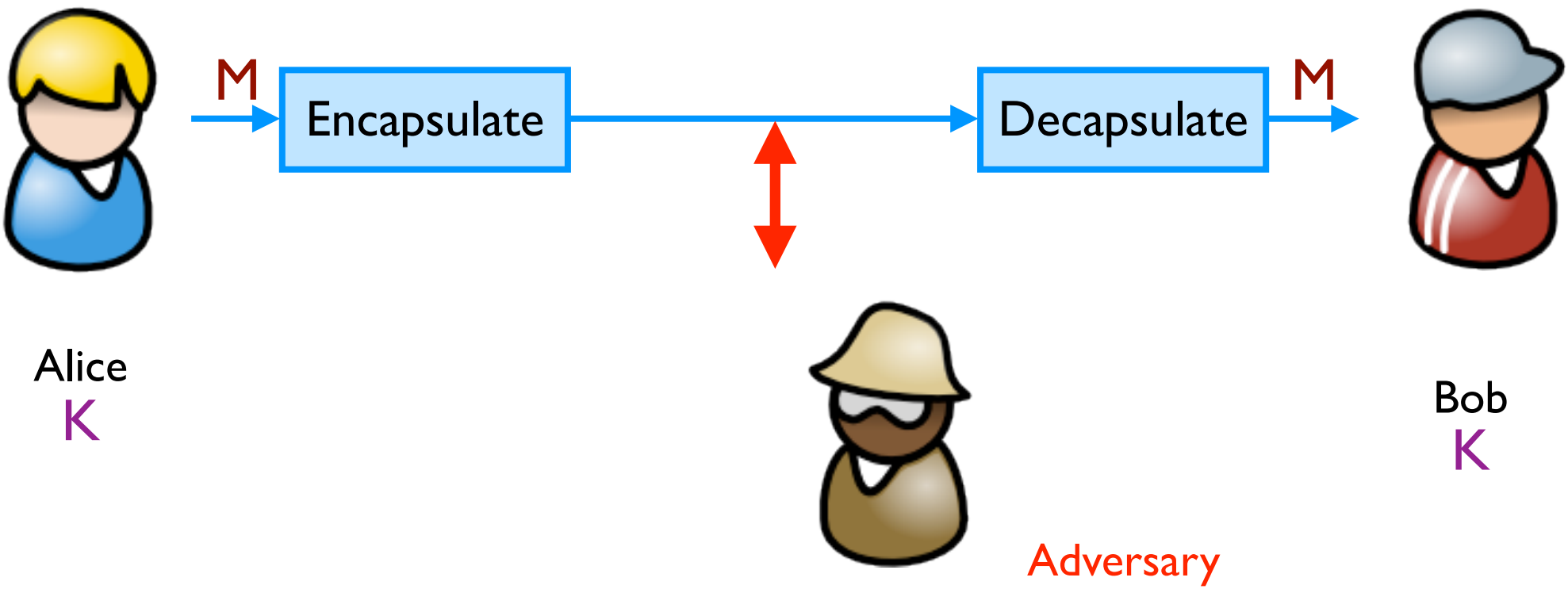

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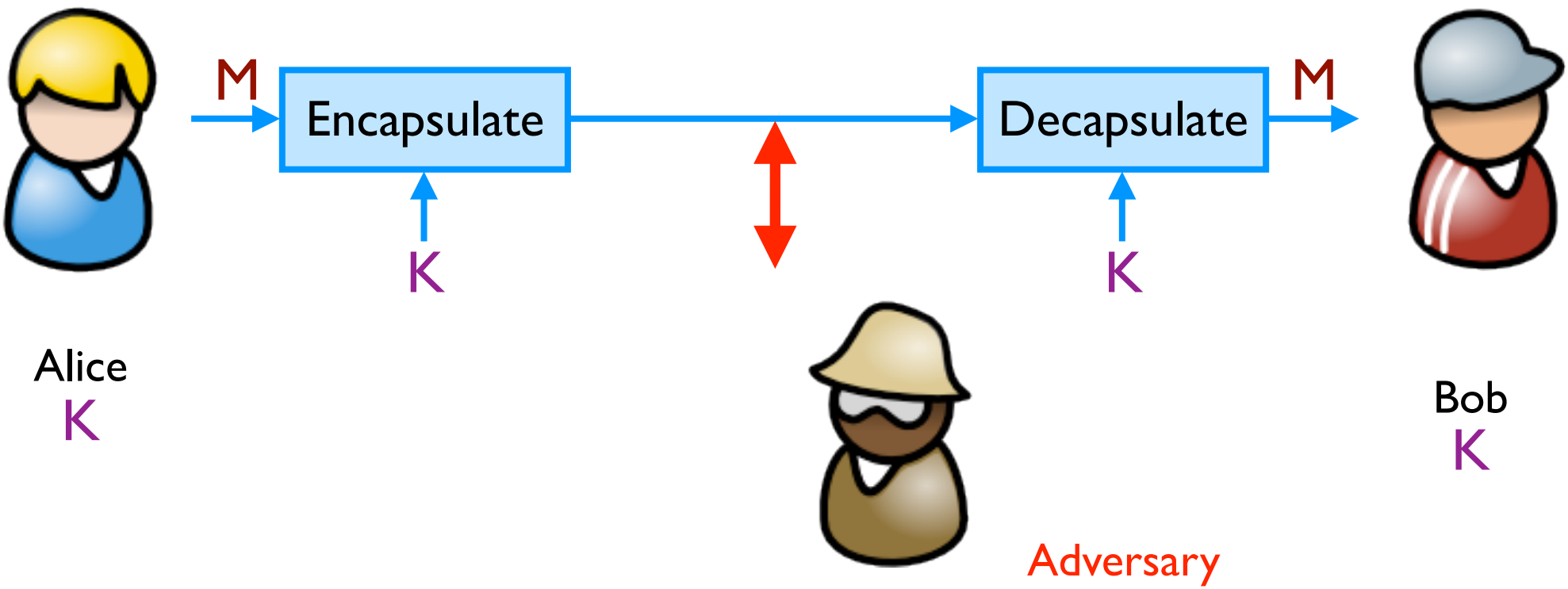
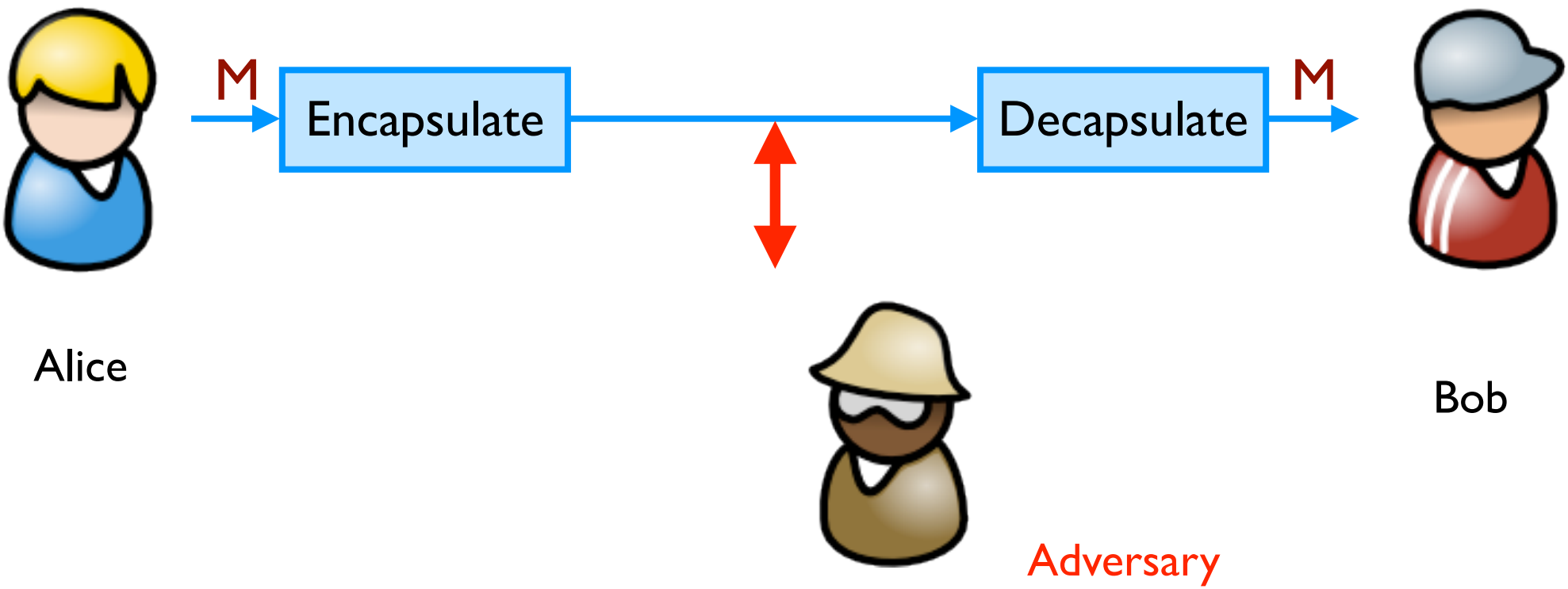


Asymmetric Setting

Each party creates a public key pk and a secret key sk.



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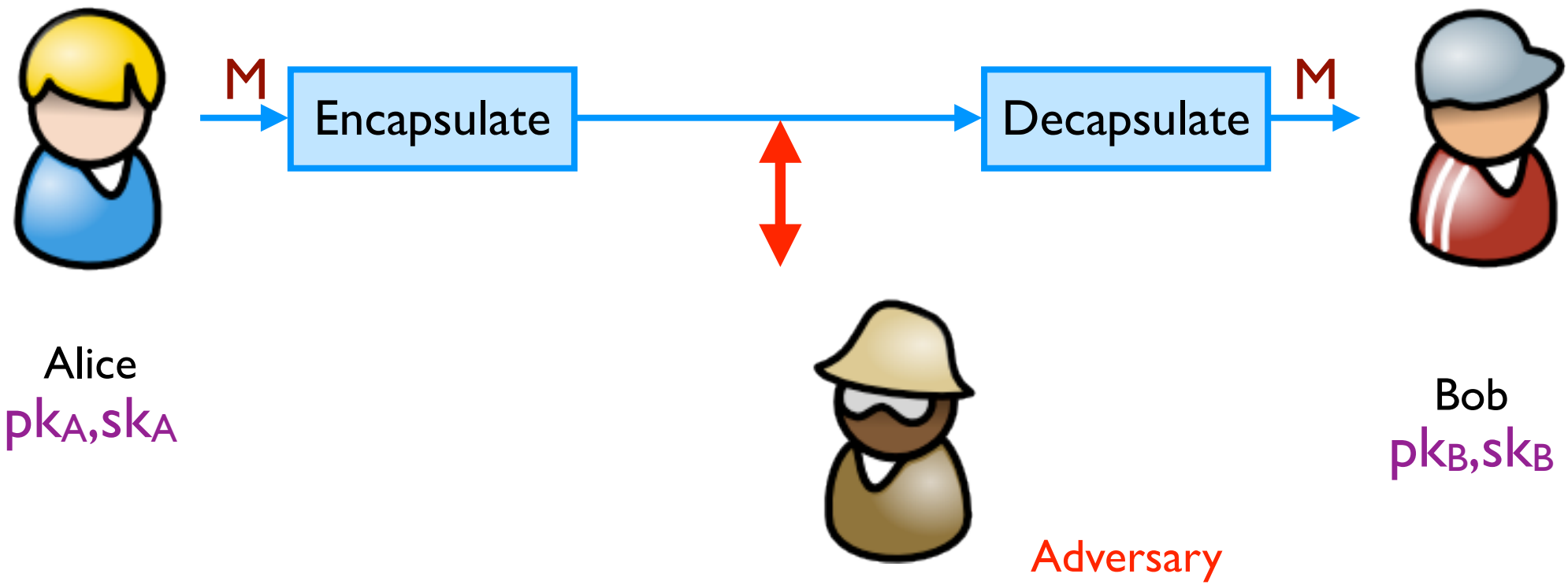

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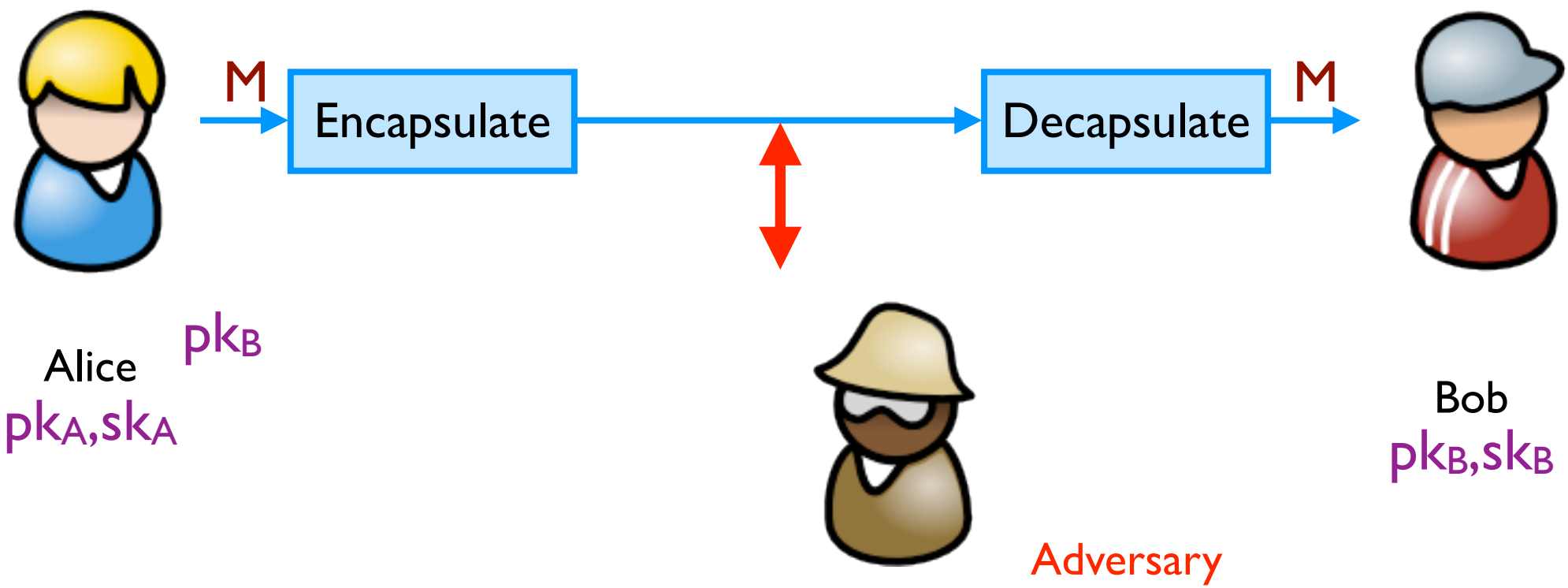

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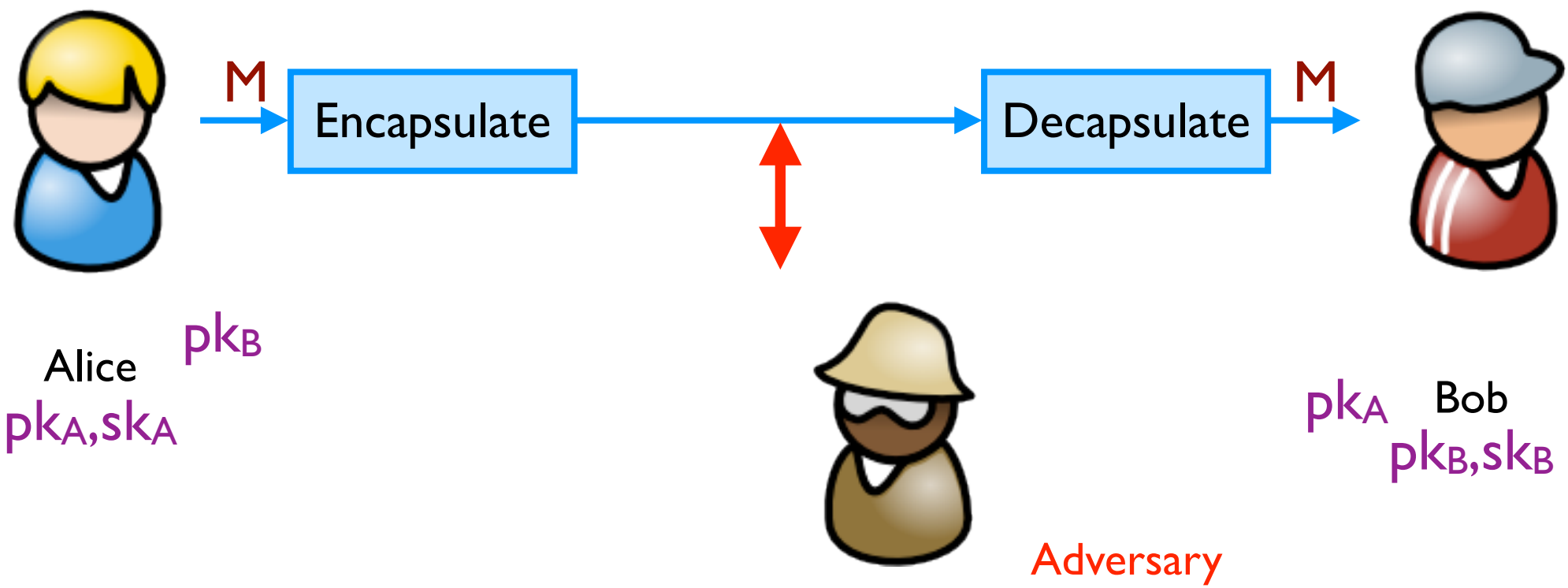

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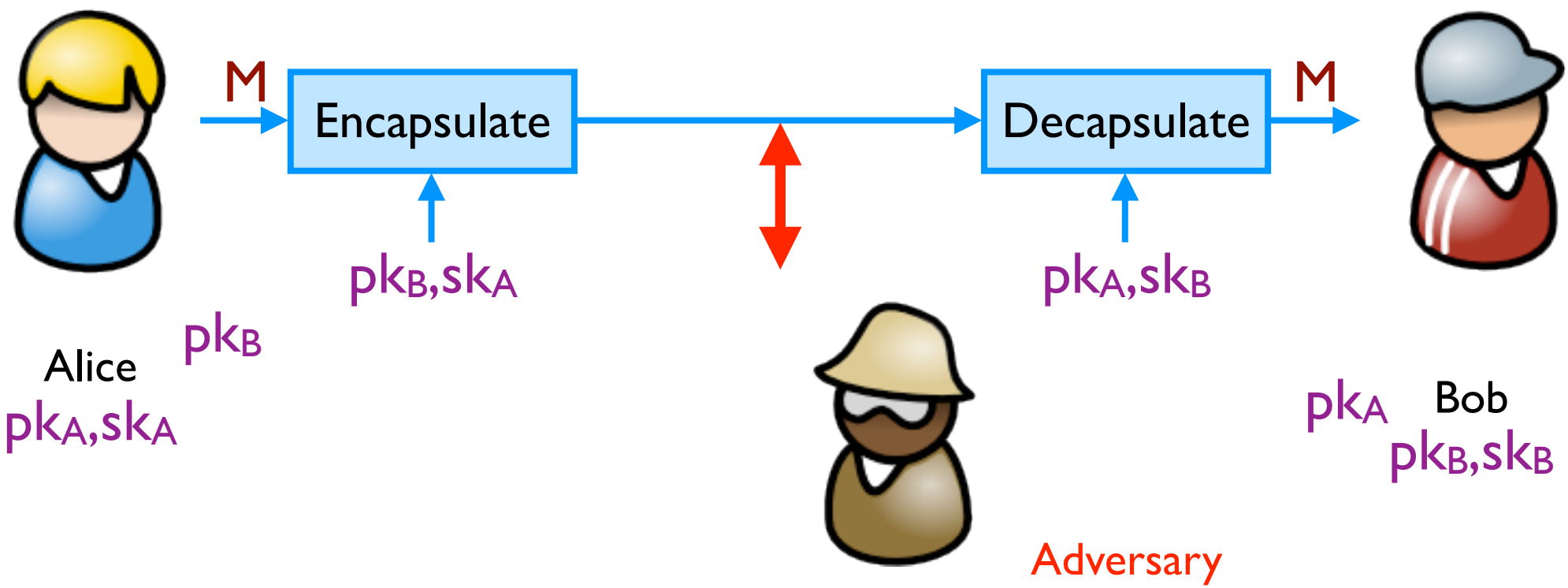
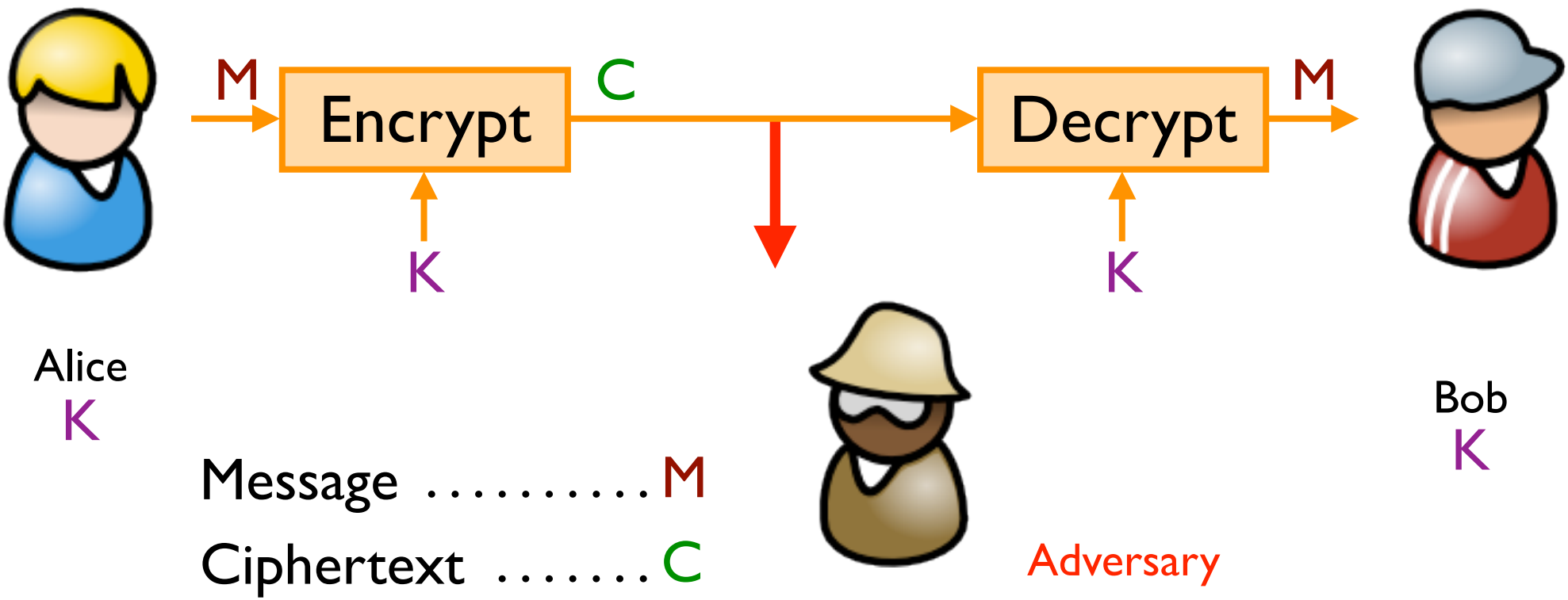


Achieving Privacy (Symmetric)

Encryption schemes: A tool for protecting privacy.



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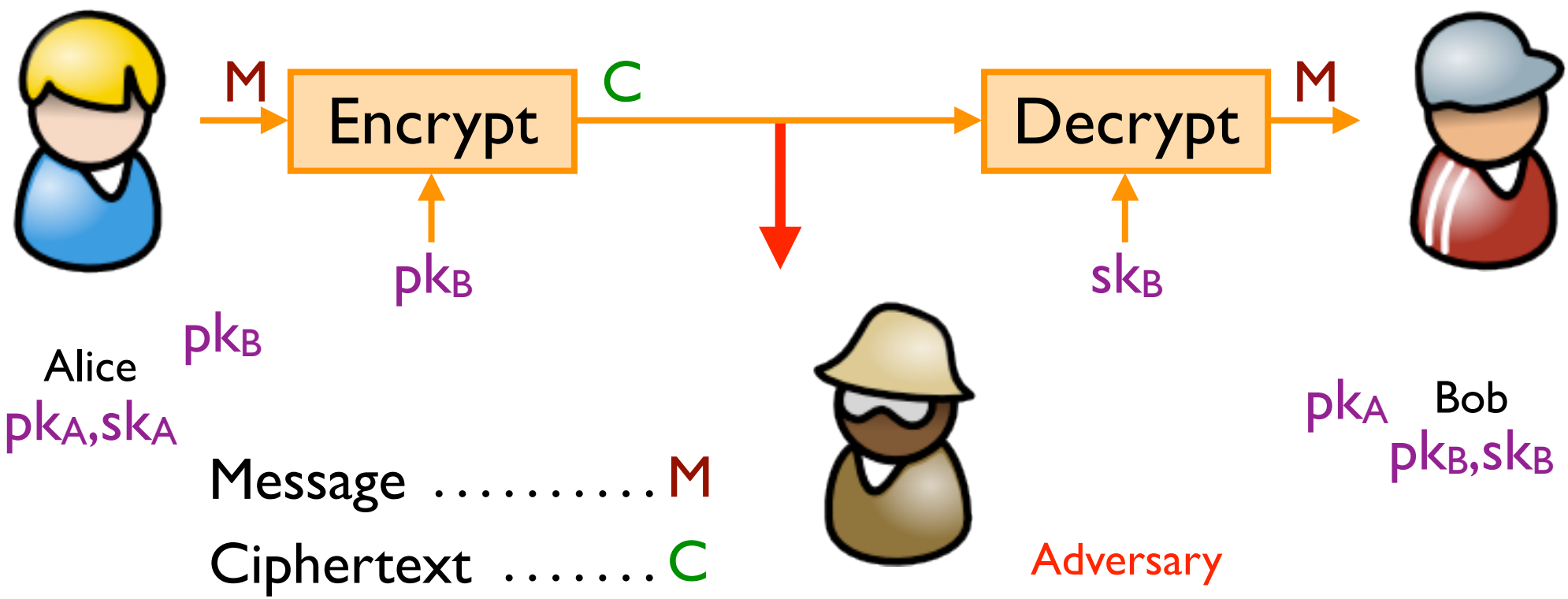
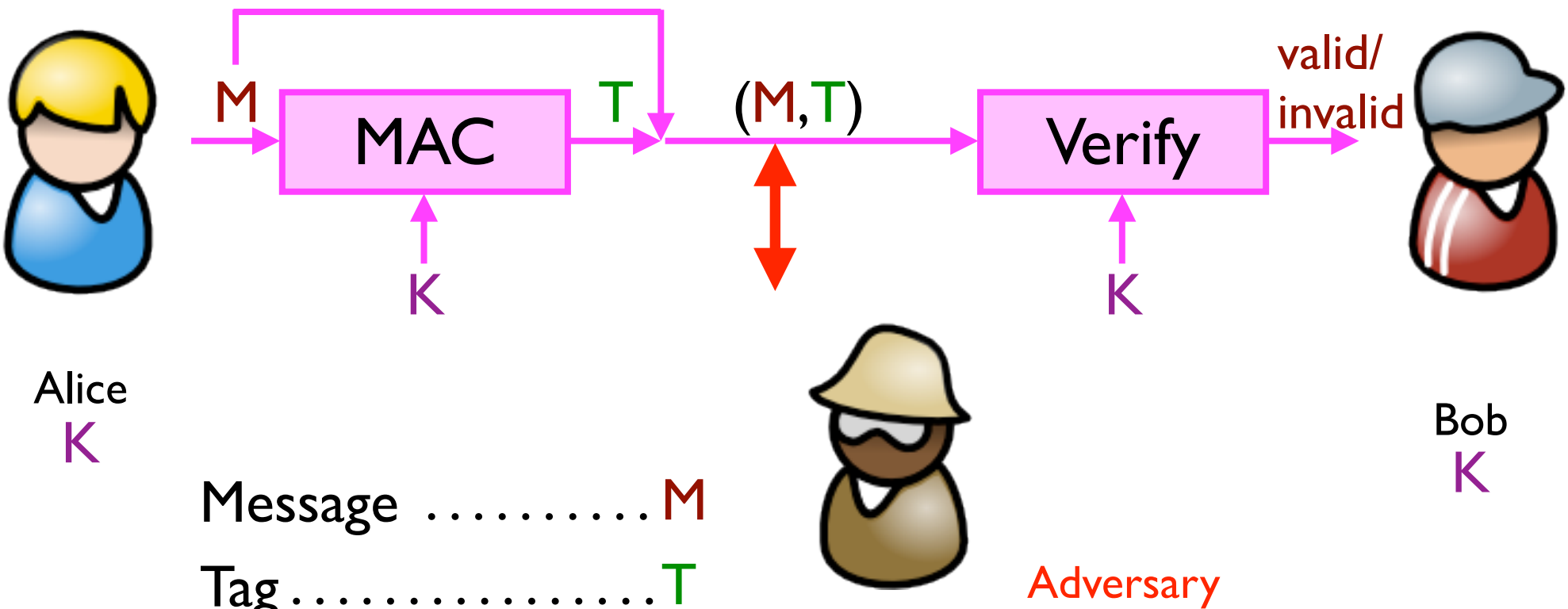


Achieving Integrity (Symmetric)

Message authentication schemes: A tool for protecting integrity.

(Also called message authentication codes or MACs.)



Achieving Integrity (Asymmetric)

Digital signature schemes: A tool for protecting integrity and authenticity.